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EFFECTS OF MONGOOSE ODORS ON RAT CAPTURE SUCCESS

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Abstract—Wild rats, *Rattus norvegicus*, *R. exulans*, and *R. rattus*, avoided wire-cage live traps that had previously captured mongooses, *Herpestes auropunctatus*. Replacing traps soiled by mongooses with clean traps would increase rat capture success and reduce a source of experimental bias.

Key Words—*Herpestes auropunctatus*, predator odors, *Rattus*, semiochemicals, trap success.

INTRODUCTION

Many animals utilize olfactory cues to detect potential danger from predators (Griffith, 1920; Weldon, 1990; Ylönen et al., 1992; Epple et al., 1993; Jędrzejewski et al., 1993). Recently much interest has focused on the use of predator odors to reduce damage by agricultural pests (Shumake, 1977; Sullivan et al., 1988c; Müller-Schwarze, 1990; Mason et al., 1994). Predator odors have been used to repel mountain beavers (*Aplodontia rufa*) (Epple et al., 1993; Nolte et al., 1993), voles (*Microtus* spp.) (Merkens et al., 1991; Sullivan et al., 1988a, 1990a), pocket gophers (*Thomomys talpoides*) (Sullivan et al., 1988b, 1990b), house mice (*Mus musculus*) (Coulston et al., 1993), snowshoe hares (*Lepus Americanus*) (Sullivan et al., 1985; Sullivan, 1986), woodchucks (*Marmota monax*) (Swihart, 1991), deer (*Odocoileus hemionus*) (Müller-Schwarze, 1972;

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Melchiors and Leslie, 1985), elk (*Cervus elaphus*) (Andelt et al., 1992), and sheep (*Ovis aries*) (Arnould and Signoret, 1993).

Predator odors can also substantially depress rodent population estimates obtained by live trapping (Stoddart, 1976, 1982). Short-tailed voles (*Microtus agrestis*) avoided traps scented with weasel (*Mustela nivalis*) anal gland secretions (Stoddart, 1976, 1979, 1982). Capture success of Orkney voles (*Microtus arvalis*) was lower in traps soiled with red fox (*Vulpes vulpes*) fecal odors (Calder and Gorman, 1991) or stoat scent (Gorman, 1984). House mice (Dickman, 1992), wood mice (*Apodemus sylvaticus*) (Dickman and Doncaster, 1984), and voles (*Clethrionomys glareolus* and *Microtus agrestis*) (Dickman and Doncaster, 1984) shunned traps tainted with red fox fecal odors.

Personnel at the Hawaii Field Station of the Denver Wildlife Research Center, US Department of Agriculture, routinely capture rats (*Rattus norvegicus*, *R. rattus*, and *R. exulans*) for laboratory and field studies related to crop pest management. Small Indian mongooses (*Herpestes auropunctatus*) frequently enter live traps set for rats, potentially biasing trap results. We analyzed trapping records from a study conducted on a Hawaiian sugarcane plantation to determine whether mongoose captures affected subsequent capture success for rats.

METHODS AND MATERIALS

We conducted the study at the Mauna Kea Agribusiness Company, Inc., a 6000-ha sugarcane plantation on the windward coast of the island of Hawaii. We divided each of six fields with sugarcane 16–26 months of age into three comparable sections of 12–18 ha each. We set 50 steam-cleaned Haguruma wire-cage live traps (22 × 28 × 15 cm) along a 150-m transect starting from an interior road and extending into the interior of each section. At each trap site, we cleared an area approximately 30 × 30 cm to one side of the transect and secured a trap directly on the ground with a numbered wire flag. We scattered grated coconut along the traplines three days before baiting the traps with coconut chunks and setting them. Between 0630 and 1200 hr on each of the succeeding four days, we checked, rebaited, and reset traps as necessary; we collected the traps on the fourth day. We identified and released captures at their respective trap sites.

To determine whether capturing a mongoose in a trap affected subsequent rodent capture success, we compared rat capture success during nights 2–4 for traps that captured a mongoose on the first night versus traps that did not capture a mongoose on the first night. We excluded traps with mongoose captures on nights 2, 3, and 4 to avoid potential bias due to repellent effects and due to the traps already being occupied and unavailable to rodents part of the time.

TABLE 1. NUMBER OF MONGOOSES CAPTURED DURING 4 DAYS OF TRAPPING AND SUBSEQUENT NUMBER OF RATS CAPTURED IN SAME TRAPS

	Day			
	1	2	3	4
Mongooses captured (N)	17	9[a]	3	4
Rats subsequently captured in same traps (N)	1	1	0	

[a]Two traps that captured a mongoose on day 2 subsequently captured another mongoose on day 4.

RESULTS

We captured 33 mongooses in 31 different traps during 3600 trap-nights (Table 1). Two traps that captured mongooses during the second day subsequently captured another mongoose during the fourth day; no other traps captured >1 mongoose. Four traps captured mongooses during the final 24 hr of trapping and thus had no subsequent chance to capture rats. Of the 29 traps that captured a mongoose with trap-nights remaining, only two captured a rodent during 72 subsequent trap-nights. Seventeen traps captured a mongoose on the first night, of which only one (6%) subsequently captured a rat. This is a substantially smaller proportion than the 208 of 869 traps (24%) that did not capture a mongoose but captured ≥ 1 rat on days 2–4 ($P = 0.06$, one-tailed Fisher's exact test).

DISCUSSION

Pheromones serve several functions in mammals, including regulating social behavior, marking territories, and signaling reproductive receptiveness. Predator odors generally attract other predators (Teranishi et al., 1980; Fagre et al., 1981), and many commercial predator lures and baits utilize predator-derived compounds (Blom, 1993). That only two of our traps captured >1 mongoose may indicate that captive mongooses emitted a stress odor that repelled other mongooses.

Most rodents are under intense selective pressure to assess and avoid predatory risks (Lima and Dill, 1990). By signaling the recent presence of predators in an area, residual predator odors may provide an early warning that enables potential prey to avoid fatal encounters with predators. Such predator avoidance behavior is widespread among rodents (e.g., Epple et al., 1993; Sullivan et al., 1988a,b; Coulston et al., 1993; Swihart, 1991) and is generally resistant to habituation (Swihart, 1991; Arnould and Signoret, 1993; Epple et al., 1993). Rats form a major portion of the diet of mongooses in and around Hawaiian sugarcane fields (Baldwin et al., 1952; Kami, 1964), and one would expect them to avoid areas frequented by these predators. Clearly most of the rats in our study avoided traps soiled with mongoose odor. This avoidance persisted for up to three days after mongooses visited the traps.

Our results indicate that replacing traps soiled by mongooses with clean traps would increase rat capture success and reduce a source of experimental bias. Further investigation is warranted to explore the use of predator odors as nonlethal repellents to reduce crop damage by rats.

REFERENCES

ANDELT, W.F., BAKER, D.L., and BURNHAM, K.P. 1992. Relative preference of captive cow elk for repellent-treated diets. *J. Wildl. Manage.* 56:164–173.

ARNOULD, C., and SIGNORET, J.-P. 1993. Sheep food repellents: Efficacy of various products, habituation, and social facilitation. *J. Chem. Ecol.* 19:225–236.

BALDWIN, P.H., SCHWARTZ, C.W., and SCHWARTZ, E.R. 1952. Life history and economic status of the mongoose in Hawaii. *J. Mammal.* 33:335–356.

BLOM, S. 1993. A primer to ingredients used for coyote lures and baits. *The Probe* 135:1, 4–6.

CALDER, C.J., and GORMAN, M.L. 1991. The effects of red fox *Vulpes vulpes* faecal odours on the feeding behaviour of Orkney voles *Microtus arvalis*. *J. Zool. London* 224:599-606.

COULSTON, S., STODDART, D.M., and CRUMP, D.R. 1993. Use of predator odors to protect chick-peas from predation by laboratory and wild mice. *J. Chem. Ecol.* 19:607–612.

DICKMAN, C.R. 1992. Predation and habitat shift in the house mouse, *Mus musculus*. *Ecology* 73:313–322.

DICKMAN, C.R., and DONCASTER, C.P. 1984. Responses of small mammals to red fox (*Vulpes vulpes*) odour. *J. Zool. London* 204:521-531.

EPPLE, G., MASON, J.R., NOLTE, D.L., and CAMPBELL, D.L. 1993. Effects of predator odors on feeding in the mountain beaver (*Aplodontia rufa*). *J. Mammal.* 74:715–722.

FAGRE, D.B., BUTLER, B.A., HOWARD, W.E., and TERANISHI, R. 1981. Behavioral responses of coyotes to selected odors and tastes. *Proc. World Furbearer Conf.* 2:966–983.

GORMAN, M.L. 1984. The response of prey to stoat (*Mustela erminea*) scent. *J. Zool. London* 202:419–423.

GRIFFITH, C.R. 1920. The behavior of white rats in the presence of cats. *Psychobiology* 2:19–28.

JĘDRZEJEWSKI, W., RYCHLIK, L., and JĘDRZEJEWSKA, B., 1993. Responses of bank voles to odours of seven species of predators: Experimental data and their relevance to natural predator–vole relationships. *Oikos* 68:251-257.

KAMI, H.T. 1964. Foods of the mongoose in the Hamakua district, Hawaii. *Zoonoses Res.* 3:165–170.

LIMA, S.L., and DILL, L.M. 1990. Behavioral decisions made under the risk of predation: A review and prospectus. *Can. J. Zool.* 68:619–640.

MASON, J.R., EPPLE, G., and NOLTE, D.L. 1994. Semiochemicals and improvements in rodent control, pp. 327-345, *in* B.G. Galef, M. Mainardi, and P. Valsecchi (eds.). Behavioral Aspects of Feeding: Basic and Applied Research in Mammals. Harwood Academic, Chur, Switzerland.

MELCHIORS, M.A., and LESLIE, C.A. 1985. Effectiveness of predator fecal odors as black-tailed deer repellents. *J. Wildl. Manage.* 49:358-362.

MERKENS, M., HARESTAD, A.S., and SULLIVAN, T.P. 1991. Cover and efficacy of predator-based repellents for Townsend's vole, *Microtus townsendii*. *J. Chem. Ecol.* 17:401–412.

MÜLLER-SCHWARZE, D. 1972. Responses of young black-tailed deer to predator odors. *J. Mammal.* 53:393–394.

MÜLLER-SCHWARZE, D. 1990. Leading them by their noses: animal and plant odours for managing vertebrates, pp. 585–598, *in* D.W. MacDonald, D. Müller-Schwarze, and S.E. Natynczuk (eds.). Chemical Signals in Vertebrates 5. Oxford University Press, New York.

NOLTE, D.L., FARLEY, J.P., CAMPBELL, D.L., EPPLE, G.M., and MASON, J.R. 1993. Potential repellents to prevent mountain beaver damage. *Crop Prot.* 12:624–626.

SHUMAKE, S.A. 1977. The search for applications of chemical signals in wildlife management, pp. 357–376, *in* D. Müller-Schwarze and M.M. Mozell, (eds.). Chemical Signals in Vertebrates. Plenum Press, New York.

STODDART, D.M. 1976. Effect of the odour of weasels (*Mustela nivalis* L.) on trapped samples of their prey. *Oecologia* 22:439–441.

STODDART, D.M. 1979. Some responses of a free living community of rodents to the odors of predators, pp. 1–10, *in* D. Müller-Schwarze and R.M. Silverstein (eds.). Chemical Signals, Vertebrates and Aquatic Invertebrates. Plenum Press, New York.

STODDART, D.M. 1982. Does trap odour influence estimation of population size of the short-tailed vole, *Microtus agrestis*? *J. Anim. Ecol.* 51:375–386.

SULLIVAN, T.P. 1986. Influence of wolverine (*Gulo gulo*) odor on feeding behavior of snowshoe hares (*Lepus Americanus*). *J. Mammal.* 67:385–388.

SULLIVAN, T.P., NORDSTROM, L.O., and SULLIVAN, D.S. 1985. Use of predator odors as repellents to reduce feeding damage by herbivores. I. Snowshoe hares (*Lepus Americanus*). *J. Chem. Ecol.* 11:903–920.

SULLIVAN, T.P., CRUMP, D.R., and SULLIVAN, D.S. 1988a. Use of predator odors as repellents to reduce feeding damage by herbivores. III Montane and meadow voles (*Microtus montanus* and *Microtus pennsylvanicus*). *J. Chem. Ecol.* 14:363-377.

SULLIVAN, T.P., CRUMP, D.R., and SULLIVAN, D.S. 1988b. Use of predator odors as repellents to reduce feeding damage by herbivores. IV. Northern pocket gophers (*Thomomys talpoides*). *J. Chem. Ecol.* 14:379-389.

SULLIVAN, T.P., SULLIVAN, D.S., CRUMP, D.R., WEISER, H., and DIXON, E.A. 1988c. Predator odors and their potential role in managing pest rodents and rabbits. *Proc. Vertebr. Pest Conf.* 13:145–150.

SULLIVAN, T.P., CRUMP, D.R., WIESER, H., and DIXON, E.A. 1990a. Comparison of release devices for stoat (*Mustela erminea*) semiochemicals used as montane vole (*Microtus montanus*) repellents. *J. Chem. Ecol.* 16:951–957.

SULLIVAN, T.P., CRUMP, D.R., WIESER, H., and DIXON, E.A. 1990b. Response of pocket gophers (*Thomomys talpoides*) to an operational application of synthetic semiochemicals of stoat (*Mustela erminea*). *J. Chem. Ecol.* 16:941–949.

SWIHART, R.K. 1991. Modifying scent-marking behavior to reduce woodchuck damage to fruit trees. *Ecol. Appl.* 1:98–103.

TERANISHI, R., MURPHY, E.L., STERN, D.J., HOWARD, W.E., and FAGRE, D.F. 1980. Chemicals useful as attractants and repellents for coyotes. *Proc. World Furbearer Conf.* 3:1839–1851.

WELDON, P.J. 1990. Responses by vertebrates to chemicals from predators, pp. 500–521, *in* D.W. Macdonald, D. Müller-Schwarze, and S.E. Natynczuk (eds.). Chemical Signals in Vertebrates 5. Oxford University Press, New York.

YLÖNEN, H., JĘDRZEJEWSKA, B., JĘDRZEJEWSKI, W., and HEIKKILÄ, J. 1992. Antipredatory behaviour of *Clethrionomys* voles—"David and Goliath" arms race. *Ann. Zool. Fenn.* 29:207–216.